The storm surge barrier on the Nieuwe Waterweg, together with the Hartel barrier, constitute the final elements of the Delta works, the plan for protecting the Netherlands against the sea.

Storm surge barrier on the Nieuwe Waterweg

The Maeslant barrier

Ministerie van Verkeer en Waterstaat

Zuid-Holland's state-of-the-art security system

Construction of the Maeslant barrier, april 1996

On the Nieuwe Waterweg, close to Hoek van Holland, one finds the final element of the Delta works. In May 1997 the Maeslant storm surge barrier was officially commissioned. The barrier protects some 1 million people in and around Rotterdam against floods.
Imposing white structures tower over the flatlands at Hoek van Holland: the storm surge barrier is a conspicious beacon along the Nieuwe Waterweg. The barrier has 2 barrier 'gates' which alone will be able to shut off the 360 meter wide Nieuwe Waterweg during storm floods. Under normal weather conditions, the gates are in the banks, allowing seagoing vessels to pass without hinder. The structure is nearly as long as the 300 meter high Eiffel tower. Never before has a storm surge barrier been built incorporating such huge moving parts. The construction of the Maeslant barrier and a few supplementary protective barrages in this area puts the final touches to the Delta Works, the plan designed to protect the Netherlands from the sea.

The reasons

The great flood disaster of 1953 came as a rude shock to the Netherlands. A fatal combination of a northwesterly storm and spring tides caused large areas of the Provinces of Zeeland and Zuid Holland to be flooded. The final toll was over eighteen hundred casualties and extensive damage to houses and other property. Only one conclusion could be drawn. The country was not adequately protected.

The Delta Plan proposed measures to prevent a repetition of such a disaster in the future. The dikes in Zeeland and Zuid-Holland were to be raised to the so-called 'delta height': able to withstand flood tides a metre and a half higher than those of the ill-famed storm of 1953.

In the subsequent decades, all but two of the open sea arms in the Dutch delta area were closed by means of dams. In the Hollandsche IJssel river Rijkswaterstaat (the Public Works and Water Management Department) constructed a moving storm surge barrier to protect the very low-lying hinterland. The Nieuwe Waterweg and the Westerschelde remained open. After all, the expanding sea ports of Rotterdam and Antwerp must remain accessible. Along the Nieuwe Waterweg and the Westerschelde a start was therefore made with extensive dike reinforcements.

Dikes or a storm surge barrier?

At first, the dike reinforcements along the Nieuwe Waterweg progressed smoothly. Then, in the seventies, people started protesting the raising of the dikes in urban areas. Historical buildings, including characteristic dike houses faced demolition in numerous places.

New calculations made in the eighties then revealed that even more drastic, costly dike reinforcements were required. All this occured in a period in which the government was being forced to economize. It was then that the idea of a moving storm surge barrier was revived. After studies had established that it was both technically and financially feasible, the Measlantkering only remained to be built.

Opting for a barrier

In 1987 the Minister for Transport, Public Works and Water Management orders an investigation into the feasibility of constructing a storm surge barrier on the Nieuwe Waterweg. It would have to be a moving barrier to minimize the negative effects it would have for the port of Rotterdam. The barrier would be closed only in the event of extremely high water levels: once or twice every ten years on average. A further condition was that in the case of a threatening flood the barrier should be able to lower water levels by 1.6 metres in Rotterdam and by 0.6 metres in Dordrecht. This will alleviate the need for further raising the dikes in Rotterdam. In 1991, the Minister for Transport, Public Works and Water Management gives the go-ahead for the construction of a storm surge barrier along the banks of the Nieuwe Waterweg near Hoek van Holland. The selected design for the 'moving sector gates barrier' is the one proposed by the Bouwkombinatie Maeslant Kering (BMK).

Safety through dialogue

The conditions under which the barrier has to be closed is something which requires careful consideration. On the one hand it is desirably to limit as far as possible any damage to the areas outside the dikes. On the other hand the port of Rotterdam should remain freely accessible. In late 1996 the views of all parties involved are polled and considered in an advice to the Minister for Transport, Public Works and Water Management. The final decision is that the storm surge barrier on the Nieuwe Waterweg will be closed when a water level of 3 metres above Amsterdam Ordnance Level (AOD) is expected in Rotterdam.

The worldwide rise in sea level means that in 50 years time the barrier will have to be closed more frequently: it is expected that this may be once every 5 years on average. When the Maeslant barrier is closed, the Nieuwe Waterweg will be shut for all shipping traffic. Apart from the necessary closures during storm floods a test drill will also be organized each year to check the functioning of the equipment. This will be done at times of minimum shipping traffic.

The gate is moved by a locomobile on top of the retaining wall, using a rag and pinion construction. Each locomobile is connected via a so-called push-pull rod to a 30 meter guide tower on the bank. The locomobile remains in place, following only the vertical movements of the retaining wall.

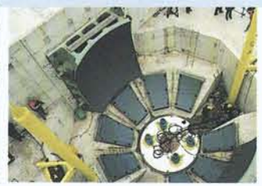
The trusses pass on the forces applied to the retaining wall to the ball joint. The trusses each are 237 metres in length. Each truss consists of 3 huge pipes. The bottom pipes have a diameter of 1.80 metres and a wall thickness of 6 to 9 centimetres.

The barrier consists of two large retaining walls or gates, which under normal conditions are 'parked' in two dry docks, one on each bank. If a storm surge is predicted, water is let into the docks causing the hollow retaining walls to start floating, allowing them to be swivelled into the Nieuwe Waterweg. When the two walls have come together, their hollow interiors are allowed to fill with water and they sink to the bottom. In this manner they close off a width of 360 metres. As soon as the high water level has passed, the walls are pumped dry. The whole structure starts to float again and both walls can be returned to their docks.

A closer look at the storm surge barrier

Locomobile

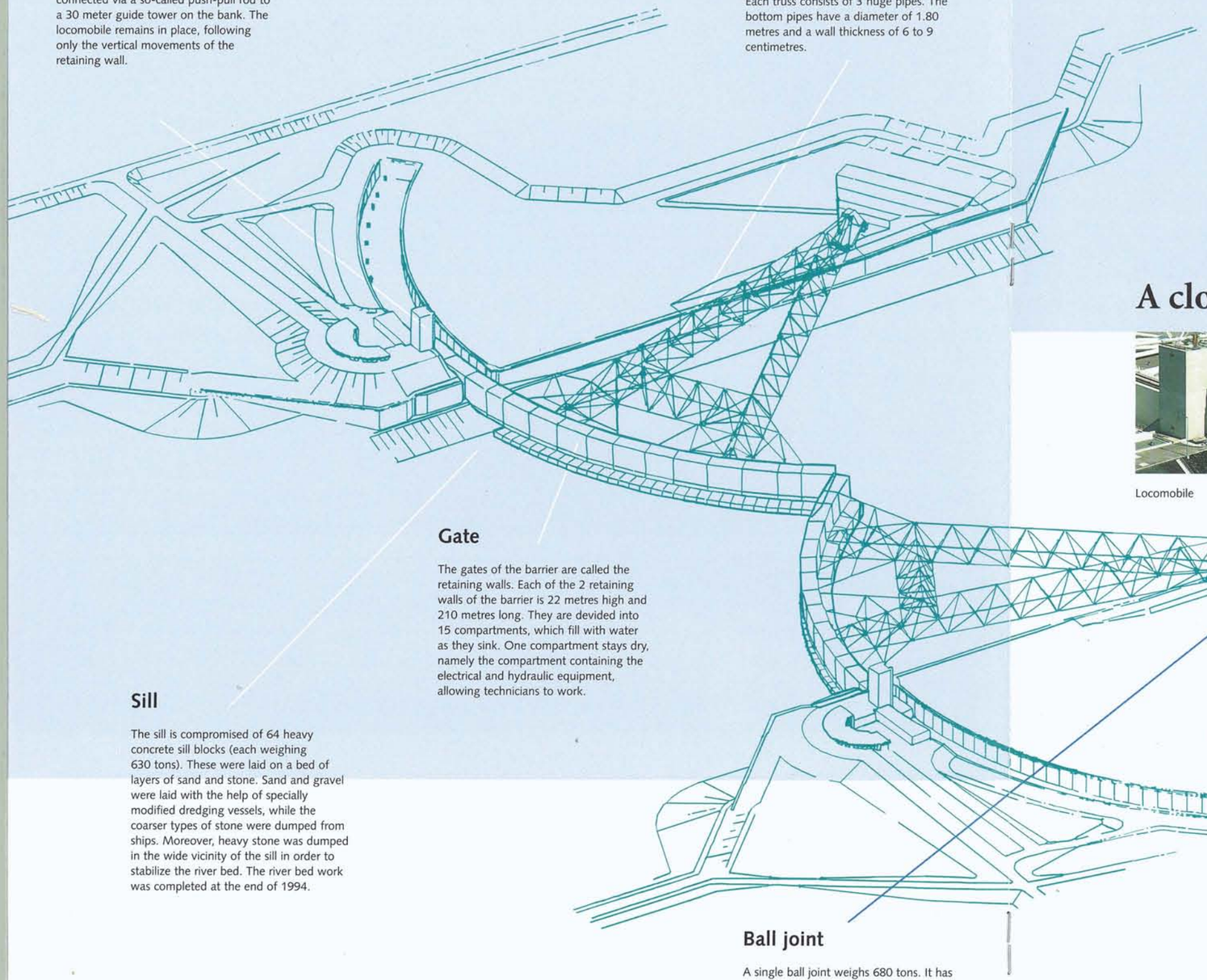
Retaining wall compartment



Ball joint element

Truss

Ball joint



Gate

The gates of the barrier are called the retaining walls. Each of the 2 retaining walls of the barrier is 22 metres high and 210 metres long. They are devided into 15 compartments, which fill with water as they sink. One compartment stays dry, namely the compartment containing the electrical and hydraulic equipment, allowing technicians to work.

Sill

The sill is compromised of 64 heavy concrete sill blocks (each weighing 630 tons). These were laid on a bed of layers of sand and stone. Sand and gravel were laid with the help of specially modified dredging vessels, while the coarser types of stone were dumped from ships. Moreover, heavy stone was dumped in the wide vicinity of the sill in order to stabilize the river bed. The river bed work was completed at the end of 1994.

Ball joint

A single ball joint weighs 680 tons. It has a steel plate core to which spheroidal cast steel elements are attached. The ball revolves in eight concave elements, also constructed from cast steel, which are attached to the concrete foundation. The cast steel parts were produced bij Skoda in the Czech Republic. Ten metres in diameter, the joint is accurate to 2 millimetres. This makes it unique in the world. The joint resembles a human shoulder joint and operates in an identical fashion. It is able to rotate in three directions, which is necessary to follow all the movements of the gates.

Ball joint base

The forces acting on the retaining wall are transmitted via the trusses and the ball joint onto a colossal triangular block of concrete weighing 52,000 tons which forms the base of the ball joint. Together, the bases can handle a force of 70,000 tons. This may be necessary during the heaviest storm conceivable, which occurs once every 10.000 years. No piles were driven under the bases. However sufficient resistance is provided by the friction between the concrete and the ground. During the heaviest storm conceivable, the joint may move 20 centimetres backwards during closure of the barrier, but will subsequently move back.

Decision & Support System (DSS)

The brain behind the storm surge barrier is a computer, the Decision and Support System (DSS). The computer uses the predicted high-water levels, actual water levels and the discharges of the Maas and Rhine rivers to continuously calculate the expected water levels in Rotterdam, Dordrecht and Spijkenisse. On the basis of this information it decides whether or not the barrier should be closed. The system is wholly automatic to reduce the possibility of human error. There are of course always people around to act if something were to go wrong. The DSS system does not only decide on closure of the Maeslant barrier, but also that of the Hartel barrier, a smaller storm surge barrier in the Hartel canal, some thirty kilometres to the southeast.





Closing and opening procedures from hour to hour

The DSS computer calculates the predicted water levels 24 hours ahead. The predictions are updated every 6 hours.

20-8 hours prior to closure
The computer (DSS) summons the operating staff.
12 hours prior to closure
Preparations at the barrier itself can commence.
8 hours prior to closure
The Haven Coordinatie Centrum (Port Coordination Centre) (HCC) is informed.
4 hours prior to closure
Water is let into the docks till it reaches the level of the river itself. The HCC sends out a warning to all shipping.
2 hours prior to closure
All shipping traffic is halted on the Nieuwe Waterweg and the Hartel canal.

Barrier closure commences.
0.5 hours after start of closure:
The gates have been floated to the centre of the Nieuwe Waterweg. The valves in the retaining walls are opened, and the sinking process starts.
1.5 hours after start of closure
The retaining walls sink to 1 metre above the sill. The high flow velocity under the walls flushes the sediment from the sill.
2.5 hours after start of closure
The retaining walls 'land' safely on a clean sill and seal off the Nieuwe Waterweg.

After the storm has passed and the water level on the river side is higher than on the sea side, the barrier can be opened again.
2 hours after start of opening
The water has been pumped from the retaining walls. The gates are floating.
2.5 hours after start of opening
The retaining walls are returned to the docks by the locomobiles. The gates of the docks can be closed, after which the water in the dock can be pumped back to the control level.

River water

The continuing flow of the river will cause the water level behind the barrier to rise but not to such an extent as to cause flooding. To prevent the build-up of river water the gates can be temporarily floated upwards. The excess river water can then flow underneath and discharge into the sea while the gates remain in position to be sunk again at the next high water level if necessary. The DSS computer decides when the gates are to be returned to the docks.

Europoort area with Maeslant barrier and Europoort defense system (including Hartel barrier)

The Hartel barrier

Protection of the lower reaches area

The Maeslant barrier is not an isolated edifice. Rotterdam and surrounding areas will only be safe if other structures are also built: the Europoortkering (Europoort defence system), plus the dike reinforcements to be carried out in the lower reaches area of the major rivers. This is the area between Dordrecht and Hoek van Holland, allong the Nieuwe Maas and the Nieuwe Waterweg. The Europoortkering protects the entire lower reaches area from flooding via the Europoort area.

Europoort barrier

The Europoort line of defense starts with a low dike at the Rozenburg point and connects to the southern edge of the Measlant barrier. The defense system continues on in southeast direction and ends with the Hartel barrier in the Hartel canal. In many places, construction of a new dike is unnecessary, as use can be made of existing elements in the landscape. A special aspect is that the water does not have to be stemmed everywhere. In places where the hinterland allows it, the water may run along or over the dike. This creates additional room for the river and allows nature to take its course.

The costs

The price tag attaching to the construction of the Maeslant barrier was considerably more friendly than the costs which would have accompanied large-scal dike reinforcements. The costs of the entire project came to 1.4 bilion guilders (1987 price level). These compromised the costs of the storm surge barrier, the Europoort defense system and the final dike reinforcements in the tidal river area - a good 400 million guilders less than the plan to continue with the then current dike reinforcements programme, and what is more, decades faster to build.

Colophon

A publication of
Rijkswaterstaat, Directie Zuid-Holland
Dienstkring Nieuwe Waterweg

Concept and realization
Podium Bureau voor educatieve communicatie bv
N.A.P., Amsterdam (Sabine Mannel & Ris van Overeem)
Ecoplus

Photographs
Rijkswaterstaat, Meetkundige Dienst
Aeroview
Joost Margés
BMK

May 1998

For more information, please contact

Het Keringhuis
Information Centre Maeslant barrier
Nieuw Oranjekanaal 139
3135 XL Hoek van Holland
Telephone: 0031 (0)174-511222
Fax: 0031 (0)174-540324
E-mail: kering@podium.nl

Internet adres:

www.keringhuis.nl

€ 1,00 = fl. 2,20